Intel® Select Solutions for Open Cloud

With the rapid pace of digital innovation, the business world is dramatically transforming. A critical aspect of this transformation is how organizations are evolving their infrastructures. Against this backdrop, software-defined solutions have become the main driver for creating efficiency and agility in areas including storage, networking, and compute to better manage the vast volumes of data. Virtualizing and scheduling physical resources with software helps to satisfy workloads of different sizes, service levels, and performance requirements.

An increasing number of organizations are aware of the limitations associated with infrastructure services based on proprietary technologies that do not provide the ability to change vendors, address information security risks, have low scalability, and or be cost effective. Solutions based on open source technologies have become an important aspect of digital transformation because they provide openness, efficiency, scalability, and more choices for security in cloud computing applications.

With the innovation and implementation of open source technologies, a large number of dynamic open source ecosystems have formed, represented by the widely implemented OpenStack cloud computing, Kubernetes container, and Ceph storage solutions.

Intel Select Solutions for Open Cloud Help with Cloud Deployment and Digital Innovation

With OpenStack, Ceph, Kubernetes, and other open source infrastructure software as core components, Intel Select Solutions for Open Cloud provide a full-stack solution based on 2nd Generation Intel® Xeon® Scalable processors, Intel® Optane™ persistent memory, Intel® Optane™ Solid State Drives (SSDs), Intel Ethernet Network Adapters, and other Intel technologies. These solutions include integrated Intel Resource Director Technology (Intel RDT), Vector Neural Network Instructions (VNNI), and other related technologies, and they have verified and optimized performance for virtualization, big data, and artificial-intelligence (AI) workloads. Companies can use these solutions to build and improve their data center infrastructures and provide better infrastructure-as-a-service (IaaS) and platform-as-a-service (PaaS) capabilities to support AI and other applications.

For companies in the midst of cloud deployment and digital innovation, the sophistication of virtualization is of utmost importance. Companies with highly virtualized environments can switch to more sophisticated cloud architecture to improve data center automation and software-driven orchestration. Software-defined storage (SDS) based on servers and software-defined networking (SDN) provide more agile storage and network services for these companies.

Today, OpenStack has become a preferred choice for enterprises deploying cloud solutions. Building an infrastructure that supports upper-layer cloud services is a crucial step in implementing OpenStack. Intel Select Solutions for Open Cloud are comprehensive solutions
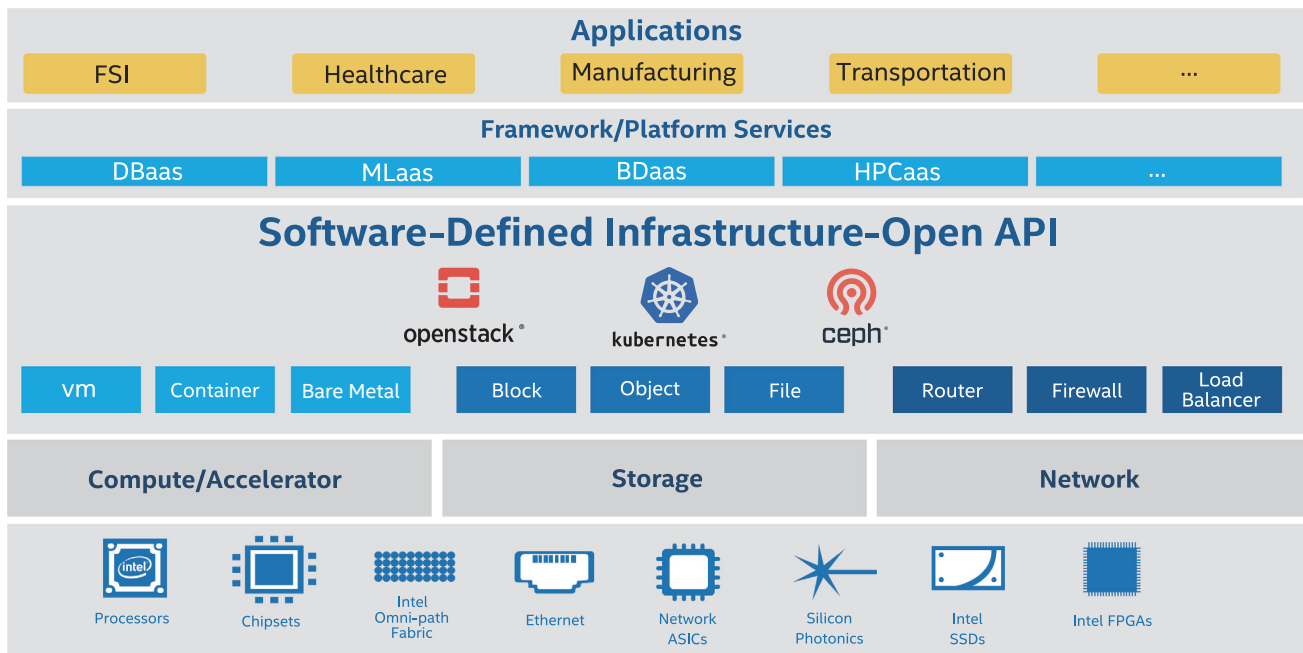
for companies and governments that simplify the cloud-deployment process. Verified for cloud data center workloads, the solutions enable agility, performance, and cost savings. They can be optimized for a wide range of workloads in industries such as government, telecommunications, finance, transport, and education.

For companies that are ready to use open source architectures such as OpenStack, Ceph, and Kubernetes in their data centers, Intel Select Solutions for Open Cloud can help them create converged infrastructure that simplify the deployment, so the hardware procurement and deployment is convenient and flexible. Specifically, Intel Select Solutions for Open Cloud have the following advantages:

- Intel Select Solutions for Open Cloud provide a "one-stop" solution for companies and governments that plan to deploy the cloud to accelerate their digital transformations.

- Verified and optimized for OpenStack, Ceph, Kubernetes, and other open source technologies on Intel's latest hardware platform, Intel Select Solutions for Open Cloud can deliver high-performance computing, storage, and networking capabilities.

- Intel Select Solutions for Open Cloud have tested and verified compatibility with specific versions of mainstream open source technologies, so users can accelerate the time to market of their systems, while reducing uncertainty.

- Through extensive support for open source technologies such as OpenStack, Ceph, and Kubernetes, Intel Select Solutions for Open Cloud allow users to flexibly combine hardware resources through

software-defined methods in an open source environment to improve agility.

- Intel Select Solutions for Open Cloud help increase the density of virtual machines (VMs) and containers, optimize hardware performance, and reduce costs.

- Open source software-defined infrastructures provide open APIs, which support more open source technologies and a wide range of workloads from cloud to edge. This satisfies the requirements of AI, deep learning (DL), and other workloads, and it increases the flexibility of future-oriented IT environments.

Intel is also advancing the development of open standards and open source technologies including OpenStack Foundation, Cloud Native Computing Foundation, Open Container Initiative, LF Edge, and other industry collaboration plans. As a result, companies' management of their cloud infrastructures will become simpler, more reliable, and more interoperable.

Hardware Selections

Intel Select Solutions for Open Cloud include 2nd Generation Intel Xeon Scalable processors, Intel Optane persistent memory, Intel Optane SSDs, and the Intel Ethernet 700 series. This foundation enables organizations to support upper-layer applications such as OpenStack, Ceph, and Kubernetes.

- **2nd Generation Intel Xeon Gold 5218 processor and Intel Xeon Gold 6222V processor:** These processors are specifically designed for

software-defined infrastructure, and they are useful in implementing software-defined infrastructure to fully tap its value. These workload-optimized processors deliver outstanding performance, and they include innovations across computing, networking, and storage platforms, while providing enhanced hardware-virtualization features. With the throughput of PCIe 3.0 x48, these processors are optimized for the most demanding input/output (I/O)-intensive workloads, and they can accelerate data insights. Furthermore, the resource-allocation technology that comes with the processors ensures the flexible scheduling of various resources. For example, resource control and orchestration are implemented using the latest resource-allocation technology. Therefore, in cache management and memory-bandwidth management, these processors are able to provide optimal services for specific applications with their orchestration functions.

- **Intel Optane persistent memory:** Intel Optane persistent memory represents a new class of memory and storage technology that allows organizations to maintain larger amounts of data closer to the processor, with consistent, low latencies and near-DRAM performance. Organizations can use Intel Optane persistent memory to cost-effectively expand the capacity of memory available to support higher quantities of "hot" data available for processing with in-memory databases, analytics, and other demanding workloads.

- **Intel SSD data center family:** For more-reliable database performance in the enterprise data center, the "Plus" configuration of the Intel Select Solutions for Open Cloud uses Intel Optane SSD DC P4800X drives and the Intel SSD DC S4510. This provides a 3.2x lower annualized failure rate (AFR) than traditional hard-disk drives (HDDs). [1]

- **Intel Ethernet Converged Network Adapter X710-DA2:** The 10Gb Intel Ethernet 700 Series Network Adapters accelerate the performance of Intel Select Solutions for Open Cloud. The Intel Ethernet 700 Series delivers validated performance ready to meet high-quality thresholds for data resiliency and service reliability with broad interoperability.[2] All Intel Ethernet products are backed by worldwide pre- and post-sales support and offer a limited lifetime warranty.

Technology Selections for Intel Select Solutions for Open Cloud

The Intel technologies integrated in 2nd Generation Intel Xeon Scalable processors can further improve the performance and reliability of Intel Select Solutions for Open Cloud:

- **Intel QuickAssist Technology (Intel QAT):** Accelerates and compresses cryptographic workloads by offloading the functions to a specialized logic engine (integrated into the chipset) and offers

enhanced data transmission and protection for server, storage, and network infrastructures.

- **Intel Deep Learning Boost (Intel DL Boost) with VNNI:** With VNNI, Intel DL Boost accelerates AI inferencing and delivers much higher performance than the previous generation of product.

- **Intel Infrastructure Management Technologies (Intel IMT):** A type of resource-management framework that combines multiple Intel functionalities and supports platform-level detection, reporting, and configuration. Intel IMT can perform enhanced hardware monitoring, management, and control, and it can help to improve data center resource efficiency and utilization.

- **Intel RDT:** Intel RDT brings new levels of visibility and control over how shared resources, such as last-level cache (LLC) and memory bandwidth, are used by applications, VMs, and containers. It's the next evolutionary leap in workload-consolidation density, performance consistency, and dynamic service delivery, helping to drive efficiency and flexibility across the data center while reducing overall total cost of ownership (TCO).

Performance Verified through Benchmark Testing

To make sure software and hardware are compatible and to optimize performance, Intel Select Solutions for Open Cloud have gone through rigorous testing and have been verified to reduce deployment time and.

In the first phase of benchmark performance test, VDBench, OpenStack Rally, and Memtier were used.

- VDBench is an I/O workload generator used for verifying data integrity and measuring the performance of directly attached and network attached storage. The storage throughput and latency requirements for multiple scenarios were tested.

- OpenStack Rally is an open source test tool released by the OpenStack community that can be used to test the performance of various OpenStack components. The number of supported virtual machines, launch time, and block-storage configuration were tested under multiple-user high-concurrency scenarios.

- Memtier is a command-line tool released by Redis Labs that can be used to generate data load in key-value storage databases for stress testing. The operations per second and the number of Redis servers were tested when the service-level agreement (SLA) latency was less than 1 millisecond (ms).

The test results of the Base and Plus configurations of Intel Select Solutions for Open Cloud are shown in Table 1.[5,6] The table shows that, for I/O-type storage workloads, the Plus configuration resulted in lower latency with more than 70K IOPS compared to 40K for the Base configuration. In the OpenStack Rally application, the Plus configuration can provide five times more VMs at a relatively low TCO (when using Intel Optane persistent memory to increase RAM). Furthermore, the Plus configuration can support more than three times as many Redis instances at a 1-ms SLA.

The Base configuration is mainly targeted at virtualization, application development, and online transaction processing (OLTP), among other applications, and it can satisfy the requirements in building cloud applications for governments, smart cities, and more. The Plus configuration is targeted at big data analysis, high-performance computing (HPC), and other such applications, and it can meet the cloud building requirements for clients of the financial-services industry and others. Users can select from the two configurations based on their budgets and performance demands. Intel Select Solutions for Open Cloud have been strictly tested for infrastructure performance, and Intel Select Solutions for Open Cloud based on Inspur InCloud OpenStack have been verified to meet related performance indicators.

Intel Select Solutions for Open Cloud Modernize Data Centers

Compared to traditional architecture, Intel Select Solutions for Open Cloud accelerate the operation speed of open source cloud, storage, and networking infrastructures by utilizing computing, storage, and network resources more efficiently. They also increase resource density at a low cost and can implement easy deployment with high performance, high quality of service (QoS), and low TCO through software-defined approaches, so as to meet the need to build open source technology–based infrastructures and lay a solid foundation for digital transformation.

Workload	Base Configuration	Plus Configuration
Storage	• 8K block, 70% read, 30% write: more than 40K I/O operations per second (IOPS) at less than 25 ms latency	• 8K block, 70% read, 30% write: more than 70K IOPS at less than 14 ms latency
VM Orchestration/Virtualization	• 100% success rate • More than 200 VMs at less than 150-second VM launch time (95th percentile) [3]	• 100% success rate • More than 1,000 VMs at less than 150-second VM launch time (95th percentile) [3]
In-Memory Database	• More than 20 instances[4] • More than 450,000 operations/second at 1 ms SLA	• More than 60 instances[4] • More than 600,000 operations/second at 1 ms SLA

Table 1: Comparison of performance test results with "Base" and "Plus" configurations

Intel Select Solutions for Open Cloud Milestones

January 2019 – Intel proposed the concept of Intel Select Solutions for Open Cloud.

September 2019 – Intel Select Solutions for Open Cloud completed optimization and verification.

November 2019 – The first version of Intel Select Solutions for Open Cloud officially released.

December 2019 – Intel Select Solutions for Open Cloud based on Inspur InCloud OpenStack released.

December 2019 – Intel Select Solutions for Open Cloud based on H3C UIS Hyper Converged Infrastructure AIO released.

February 2020 – The second version of Intel Select Solutions for Open Cloud released.

2020 – More ISVs, OEMs, and channel partners will be recruited to jointly build a more sophisticated and open ecosystem of Intel Select Solutions for Open Cloud.

Intel Xeon Scalable Processors

2nd Generation Intel Xeon Scalable processors:

- Offer high scalability that is cost-efficient and flexible, from the multi-cloud to the intelligent edge

- Establish a seamless performance foundation to help accelerate data's transformative impact

- Support breakthrough Intel Optane persistent memory technology

- Accelerate AI performance and help deliver AI readiness across the data center

- Provide hardware-enhanced platform protection and threat monitoring

Intel Select Solutions for Open Cloud Partner Program

So far, Inspur, H3C, and some other vendors have become partners of Intel Select Solutions for Open Cloud. Intel will recruit more ISVs, OEMs, and channel partners to collaborate on Intel Select Solution for Open Cloud, in order to build a more sophisticated and open ecosystem. For business and technical cooperation on Intel Select Solutions for Open Cloud, email **opencloud@intel.com**

Appendix 1: Intel Select Solutions for Open Cloud Base and Plus Configurations (Three Controllers, Three Compute/Storage Nodes)

Base Configuration of Intel Select Solutions for Open Cloud

Six Nodes	Three Controllers	Three Compute/Storage Nodes
Processor	2 x Intel Xeon Gold 5118/5218 processor (2.30 GHz, 12 cores/16 cores), or a higher model number Intel Xeon Scalable processor	2 x Intel Xeon Gold 5118/5218 processor (2.30 GHz, 12 cores/16 cores), or a higher model number Intel Xeon Scalable processor
RAM	192 GB or higher	192 GB or higher
Persistent Memory	Not applicable (N/A) (optional)	N/A (optional)
Boot Disk	1 x Intel SSD DC S4510 or higher series at 480 GB or larger	1 x Intel SSD DC S4510 or higher series at 480 GB or larger
Storage Cache	N/A (optional)	N/A (optional)
Storage Disk	1 x Intel SSD DC S4510 or higher series at 1.92 TB or larger	4 x Intel SSD DC S4510 or higher series at 1.92 TB or larger
Data Network	2 x 10 GB dual-port Intel Ethernet Converged Network Adapter XXV710-DA2 SFP+ or better	2 x 10 GB dual-port Intel Ethernet Converged Network Adapter XXV710-DA2 SFP+ or better

Plus Configuration of Intel Select Solutions for Open Cloud

Six Nodes	Three Controllers	Three Compute/Storage Nodes
Processor	2 x Intel Xeon Gold 5118/5218 processor (2.30 GHz, 12 cores/16 cores), or a higher model number Intel Xeon Scalable processor	2 x Intel Xeon Gold 6222V processor (1.80 GHz, 20 cores), or a higher model number Intel Xeon Scalable processor
RAM	192 GB or higher	384 GB or higher
Persistent Memory	N/A (optional)	1.0 TB (8 x 128 GB, 288-pin) Intel Optane persistent memory
Boot Disk	1 x Intel SSD DC S4510 or higher series at 480 GB or larger	1 x Intel SSD DC S4510 or higher series at 480 GB or larger
Storage Cache	N/A (optional)	1 x Intel Optane SSD DC P4800X or higher series at 375 GB or larger
Storage Disk	1 x Intel SSD DC S4510 or higher series at 1.92 TB or larger	4 x Intel SSD DC P4510 or higher series at 2.0 TB or larger
Network	2 x 10 Gb dual-port Intel Ethernet Converged Network Adapter XXV710-DA2 SFP+ or better	2 x 10 Gb dual-port Intel Ethernet Converged Network Adapter XXV710-DA2 SFP+ or better

[1] Based on initial product AFR of 0.66 percent vs. industry AFR average (2.11%). Source: Backblaze. "Hard Drive Stats for Q1 2017." May 2017. backblaze.com/blog/hard-drive-failure-rates-q1-2017/

[2] The Intel Ethernet 700 Series includes extensively tested network adapters, accessories (optics and cables), hardware, and software, in addition to broad operating system support. A full list of the product portfolio's solutions is available at intel.com/ethernet. Hardware and software are thoroughly validated across Intel Xeon Scalable processors and the networking ecosystem. The products are optimized for Intel architecture and a broad operating system ecosystem: Windows, Linux kernel, FreeBSD, Red Hat Enterprise Linux (RHEL), SUSE, Ubuntu, Oracle Solaris, and VMware ESXi. Supported connections and media types for the Intel Ethernet 700 Series are: direct-attach copper and fiber SR/LR (QSFP+, SFP+, SFP28, XLPPI/CR4, 25G-CA/25G-SR/25G-LR), twisted-pair copper (1000BASE-T/10GBASE-T), backplane (XLAUI/XAUI/SFI/KR/KR4/KX/SGMII). Note that Intel is the only vendor offering the QSFP+ media type. The Intel Ethernet 700 Series supported speeds include 10GbE, 25GbE, 40GbE.

[3] Based on 1 GB vCPU, 2 GB memory VM, and 100 QPS.

[4] Based on 16 GB memory instance.

[5] The specifications listed here are the minimum requirements for OEM certification, and they only include some of the workloads tested for Intel Select Solutions for Open Cloud.

[6] Based on Intel testing as of October 11, 2019. Configurations: Base configuration: Six nodes: three controller nodes with 2 x Intel Xeon Gold 5218 processor, 16 cores, Intel Hyper-Threading Technology (Intel HT Technology) on, Intel Turbo Boost Technology on, 384 GB total memory (12 slots, 32 GB, 2,666 MHz), 1 x 480 GB Intel SSD DC S4510, 1 x 1.92 TB Intel SSD DC S4510, BIOS: SE5C620.86B.02.01.0008.031920191559 (ucode:0x5000021), CentOS 7.6, 3.10.0-957.27.2.el7.x86_64; three compute/storage nodes with 2 x Intel Xeon Gold 5218 processor, 16 cores, Intel HT Technology on, Intel Turbo Boost Technology on, 384 GB total memory (12 slots, 32 GB, 2,666 MHz), 1 x 480 GB Intel SSD DC S4510, 4 x 1.92 TB Intel SSD DC S4510, BIOS: SE5C620.86B.02.01.0008.031920191559 (ucode:0x5000021), CentOS 7.6, 3.10.0-957.27.2.el7.x86_64, Vdbench 5.04.07, OpenStack Rally 1.6.1, Redis 5.0.2, memtier 1.2.11, OpenStack Rocky, Ceph Luminous. Plus configuration: Six nodes: three controller nodes with 2 x Intel Xeon Gold 5218 processor, 16 cores, Intel HT Technology on, Intel Turbo Boost Technology on, 384 GB total memory (12 slots, 32 GB, 2,666 MHz), 1 x 480 GB Intel SSD DC S4510, 1 x 1.92 TB Intel SSD DC S4510, BIOS: SE5C620.86B.02.01.0008.031920191559 (ucode:0x5000021), CentOS 7.6, 3.10.0-957.27.2.el7.x86_64; three compute/storage nodes with 2 x Intel Xeon Gold 6240L processor, 16 cores, Intel HT Technology on, Intel Turbo Boost Technology on, 384 GB DRAM (12 slots, 32 GB, 2,666 MHz), 1.0 TB Intel Optane persistent memory (8 slots, 128 GB, 2,666 MHz), 1 x 480 GB Intel SSD DC S4510, 1 x 375 GB Intel Optane SSD DC P4800X, 4 x 1.92 TB Intel SSD DC S4510, BIOS: SE5C620.86B.02.01.0008.031920191559 (ucode:0x5000021), CentOS 7.6, 3.10.0-957.27.2.el7.x86_64, Vdbench 5.04.07, OpenStack Rally 1.6.1, Redis 5.0.2, memtier 1.2.11, OpenStack Rocky, Ceph Luminous.

Performance results are based on testing as October 11, 2019, and may not reflect all publicly available security updates.

Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more complete information visit intel.com/benchmarks

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